Backyard chemistry

Prof Hal Sosabowski presents experiments you can do on your own

In this issue: the power of atmospheric pressure

Health & Safety

Safety glasses should be worn. Ensure that no one is standing in the path of the flying ruler.

HALAJAWAD

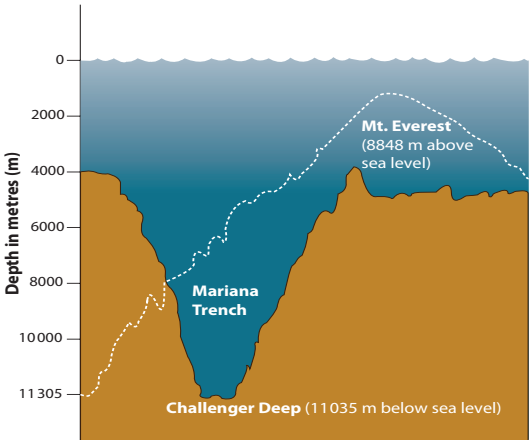
In a previous *Backyard chemistry* we saw that rapidly cooling the gas in a drinks can will cause it to collapse. In that experiment we found out that it is not merely pressure that causes the can to deform, but a difference in pressure between the inside and outside of the can. As we reduced the pressure inside the can, the pressure balance was disturbed and the can collapsed.

In this experiment, we are going to investigate the power of atmospheric pressure, in less than a second.

Atmospheric pressure is caused, literally, by the weight of the air above you. To understand it better, let's use the analogy of water pressure.

As you go deeper under water, the weight of liquid above your head pressing down on you increases. The deeper you go, the more water there is pressing down on you and the greater the pressure.

This is the same with air pressure, the higher you are, the lower the pressure. This explains why you can't make a decent cup of tea at the summit of Mount Everest! As the air pressure is so low at 8848 m, water boils at just 69°C. In fact it's about 26 kPa compared to 100 kPa at sea level. Remember, boiling point is simply the temperature at which the vapour pressure of the boiling liquid equals the surrounding pressure.



Materials

You will need:

- broadsheet newspaper
- standard 1 m wooden ruler
- safety glasses

Method

Place the ruler on a table and let one end hang over the edge by about 10 cm. For the sake of the exercise, strike the end of the ruler that is hanging over the edge of the table with the edge of your palm, taking care that no one is standing in the ruler's trajectory. As you might expect, the ruler will fly off the table.

Now repeat the experiment, but this time place a full double page of the broadsheet newspaper over the part of the ruler that rests on the table. Again, strike the ruler with the palm of your hand. The ruler will not propel the paper off the table and will in fact either be broken, or perhaps tear the paper.

The science

The ruler is held down by the large surface area of the paper. As you know, pressure is defined as force divided by area. So, the downward force of atmospheric pressure, spread over the large surface area of the newspaper, keeps the set-up pinned to the table. The upward thrust of the ruler, provided by your arm, is concentrated in a small area of the paper, so it's no match for the downward force of the atmosphere. You could think of the force as a huge column of air (about 400 km tall) resting on top of the newspaper.

You can even calculate the weight of the atmosphere pushing down on the paper. Since atmospheric pressure is approximately 100 kPa, you can calculate the area of the paper and work out the total weight pushing down on the paper. My newspaper is roughly 0.75 m by 0.85 m. That's 0.64 m^2. That means there are about 6.4 kg of weight pressing down on the paper!

Did you know?

The pressure at the bottom of the Mariana Trench in the mid Atlantic – about 11 km underwater – is a whopping 108 MPa, that is, about 1000 times higher than standard atmospheric pressure.